INVESTIGATION OF CO_2 SEQUESTRATION POSSIBILITY VIA AQUEOUS PHASE MINERAL CARBONATION USING INDUSTRIAL WASTE MATERIALS

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Degree of Master of Science

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A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Sustainable Process Engineering

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ABSTRACT

Carbon dioxide (CO_2) as the most vital greenhouse gas in the earth's atmosphere plays a major role in maintaining the global temperature. Higher concentrations of CO_2 in the atmosphere, increases amounts of heat entrapped in the atmosphere. Thus, the environmental temperature increases when the CO_2 concertation increases and results in global warming. The global CO_2 emission was approximately 35.3 billion metric tonnes in 2018 and, it is predicted to be increasing up to 43.08 billion metric tonnes by 2050 as per the prevailing trends in statistical analysis. Therefore, maintaining an acceptable concentration of atmospheric CO_2 is required. In this situation, anthropogenic CO_2 capture and storage technologies have emerged to reduce the atmospheric CO_2 concentration. Among the carbon capture methods, post-combustion CO_2 capture technologies are the most common as there is the advantage of ability to retrofitting to existing plants.

Mineral carbonation is considered as a natural and exothermic process among available post combustion CO_2 capture technologies, which gives promising results in CO_2 sequestration by storing as mineral carbonates. Suitable materials for mineralization are natural minerals like silicate rocks, serpentine, olivine minerals or else industrial wastes like oil shale ash, steel slag, paper mill waste, fly ash or mine tailing, etc.

In this study, the existing literature on CO_2 sequestration capabilities through aqueous phase mineral carbonation of industrial waste materials were reviewed and analyzed. Industrial waste materials, such as coal fly ash and steel slag have significant capture capacities and coal fly ash consumes significantly lesser energy and costs to capture one tonne of CO_2. In addition, calcium extraction from Lakvijaya Coal Fired Power Plant fly ash was experimentally investigated to identify the potential for indirect carbonation, to sequestrate CO_2 from coal flue gas. A maximum calcium extraction efficiency of 9.65% was obtained for coal fly ash obtained from Lakvijaya Coal Fired Power Plant.

Keywords: CO_2 sequestration, Mineral Carbonation, Coal Fly Ash, Industrial Waste Materials

DEDICATION

Dedicated to Dr. Mahinsasa Rathnayake, who taught me that teachers go beyond the textbooks and inspire from the heart.

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LIST OF ABBREVIATIONS

Abbreviation	Description
PCC	Post-Combustion Capture
LCPP	Lakvijaya Coal Fired Power Plant
CFA	Coal Fly Ash
VSA	Vacuum Swing Adsorption
PSA	Pressure Swing Adsorption
OSFA	Oil Shale Fly Ash
CBD	Cement Bypass Dust
APMWA	Alkaline Paper Mill Wastes Ash
MSWI	Municipal Solid Waste Incineration
EOR	Enhanced Oil Recovery
EGR	Enhanced Gas Recovery
ECMBR	Enhanced Coal Bed Methane Recovery
XRF	X-Ray Fluorescence spectrometer
SEM	Scanning Electron Microscopy